The magnetic behaviors in spin-glass FeGa$_2$O$_4$ system

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We present the investigation of magnetic properties in spin-glass FeGa$_2$O$_4$ system. From X-ray diffraction patterns of FeGa$_2$O$_4$, refined with Rietveld’s refinement method, its structure is determined to be inverse spinel [Fe$_{0.45}$Ga$_{0.55}$]$_A$[Fe$_{0.55}$Ga$_{1.45}$]$_B$O$_4$ with space group Fd-3m and the lattice parameter of $a_0$ = 8.385 Å. From temperature-dependent zero-field-cooled (ZFC) and field-cooled (FC) magnetization curves under 100, 400, and 1000 Oe, the freezing temperature is $T_f$ = 12 K. To clarify the origin of magnetic properties at low-temperature, we have measured the AC magnetic susceptibility $\chi'_\text{ac}$ of FeGa$_2$O$_4$ in the frequency range of 100-10000 Hz under 10 Oe. With increasing frequency $\nu$, the maximum of the real part of the ac susceptibility at $T_f$ shifts to higher temperatures, as in conventional spin glasses. In addition, the shift of $T_f$ can be determined from

$$\delta T_f = \frac{\Delta T_f}{T_f \Delta \log_{10} \nu}$$

(1)

The values obtained are within 0.02-0.04 at different frequencies, close to that in metallic spin glasses and slightly smaller than those in other insulating spin glasses [1].

The Mössbauer spectrum of the sample at room temperature was least-squares fitted to two quadrupole lines based on [Fe$_{0.45}$Ga$_{0.55}$]$_A$[Fe$_{0.55}$Ga$_{1.45}$]$_B$, where the subscripts $A$ and $B$ denote the tetrahedral and octahedral sites. This is consistent with the Rietveld refinement analysis from XRD measurement. The charge states of Fe ions are ferrous (Fe$^{2+}$) from isomer shift $\delta_A$ = 0.926, and $\delta_B$ = 0.840 mm/s at A and B sites at RT.

![Figure 1: The AC magnetic susceptibility as a function of temperature for FeGa$_2$O$_4$ in frequency range 100-10000 Hz under 10 Oe.](image)